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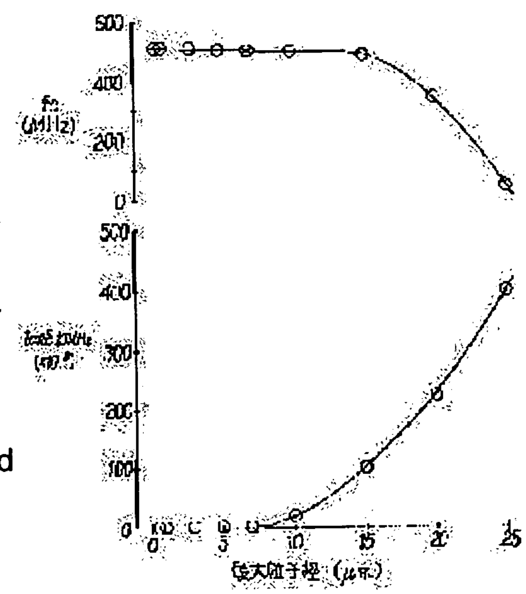
(54) HIGH-FREQUENCY SOFT MAGNETIC MATERIAL

(57)Abstract:

PURPOSE: To provide a soft magnetic material, which does not require to perform a sintering and moreover, is superior in high-frequency characteristics.



CONSTITUTION: A mixed powder of a chemical compositional ratio of NiO:CuO: ZnO:Fe2O3=15:6:31:48 is fired to obtain spinel type ferrite powder of a particle diameter of longer than 10nm and shorter than 7μm. For example, a resin is mixed in this spinel type ferrite powder to mold the mixture into a prescribed molded material and the molded material is formed into a molded article. This molded article is superior in high-frequency characteristics and if the particle diameter of the spinel type ferrite powder is longer than 10nm and shorter than 7μm, the molded article, which is superior in high-frequency characteristics, can be obtained by merely molding, in short, without going through a sintering process.

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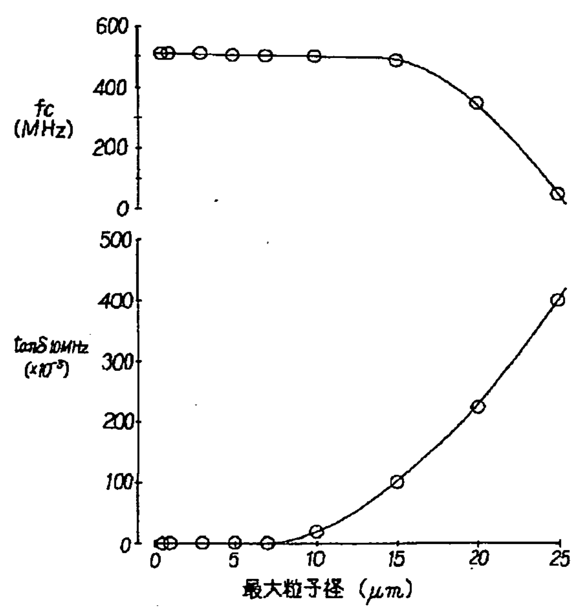
(54)【発明の名称】　高周波軟磁性材料

(57)【要約】

【目的】　焼結を行う必要がなくしかも高周波特性の優れた軟磁性材料を提供する。

【構成】　化学組成比が15ＮｉＯ・６ＣｕＯ・31ＺｎＯ・48Fe_2O_3となる混合粉末を焼成して粒子径が10ｎｍ以上7 μｍ以下のスピネル型フェライト粉末を得る。例えば、このスピネル型フェライト粉末に対して樹脂を混合して所定の成形体に成形して成形品とする。この成形品は高周波特性に優れており、スピネル型フェライト粉末の粒子径が10ｎｍ以上7 μｍ以下であれば、単に成形するだけで、つまり、焼結工程を経ることなく高周波特性の優れた成形品を得ることができる。



【特許請求の範囲】

【請求項1】　粒子径が10nm以上で7μm以下の軟磁性スピネル型フェライト粉末であることを特徴とする高周波軟磁性材料。

【発明の詳細な説明】

【0001】

【産業上の利用分野】本発明は高周波帯域で用いられる軟磁性材料に関する。

【0002】

【従来の技術】一般に、この種の軟磁性材料では透磁率（μ）が高周波帯域においても高い値を示す必要があり、このため、電気抵抗値が比較的高い値を示すスピネル型フェライト材料が用いられている。このスピネル型フェライト材料はその性質が硬くしかも脆いため、加工が困難である。このため、フェライト粉末又は原料粉末を所望の形状に成形した後、この成形体を焼結して焼結体とする粉末冶金法が用いられている。

【0003】

【発明が解決しようとする課題】ところが、上記の焼結体を得る際には、成形体を1000℃乃至1400℃の高温で焼結する必要があり、このような高温での焼結では所謂焼結収縮によって焼結体に変形が生じ、この結果、所望の形状とするには、焼結体に加工を施す必要がある。

【0004】上述のような高温での焼結には、多大なエネルギーの消費を伴うばかりでなく焼結設備が高価となってしまうという問題点がある。さらに、焼結体に加工を施すことは一般に困難であり、このため、加工費用が増加するばかりなく材料の損失につながってしまう。

【0005】さらに、高周波帯域で使用する際には、効率の面を考慮すると、スピネル型フェライト材料を小型形状に焼結加工することが望ましいが、小型形状への加工は加工精度の面で極めて困難であるという問題点がある。一方、このようなフェライト材料（インダクタ素子）と誘電材料（容量素子）とを一体焼結してL－C素子を構成する場合もあるが、このようなL－C素子では材料同士の接合面において、焼結時における原子の拡散によって特性の劣化する領域が生じてしまう。

【0006】いずれにしても焼結工程を含むことによって上述のような種々の問題点が発生してしまう。

【0007】本発明の目的は焼結を行う必要がなくしかも高周波特性の優れた軟磁性材料を提供することにある。

【0008】

【課題を解決するための手段】本発明によれば、粒子径が10nm以上で7μm以下の軟磁性スピネル型フェライト粉末をであることを特徴とする高周波軟磁性材料が得られる。

【0009】

【作用】本発明では、高周波軟磁性材料として、粒子径が10nm以上7μm以下の軟磁性スピネル型フェライト粉末を用いている。このような軟磁性スピネル型フェライト粉末は単に所望の形状に成形して成形体とするだけで、優れた磁気特性を得ることができる。そして、軟磁性スピネル型フェライトの粒子径が7μmを越えると、磁性材料として損失（例えば、10MHzにおける損失係数δ_{10MHz}）が増大してしまう。一方、軟磁性スピネル型フェライトの粒子径が10nm未満であると、フェライト粉末粒子が常磁性的挙動を呈し、軟磁性が低下する。

【0010】

【実施例】以下本発明について実施例によって説明する。

【0011】実施例1

粒度が粒度が0.5μm以下である酸化ニッケル（NiO）、酸化第2銅（CuO）、酸化亜鉛（ZnO）、及び酸化鉄（α－Fe_2O_3）を準備し、ボールミルを用いてこれら粉末を湿式混合して化学組成比が15NiO・6CuO・31ZnO・48Fe_2O_3となる原料混合粉末を得た。

【0012】次に、この原料混合粉末を大気中において急熱、急冷にて温度750℃乃至1200℃の範囲で焼成して焼成粉末を得た。そして、この焼成粉末をボールミルを用いて解砕してそれぞれ粒子径0.5μm、1.0μm、3.0μm、5.0μm、7.0μm、10.0μm、15.0μm、20.0μm、及び25.0μm以下の合計9種類のスピネル型フェライト粉末を得た。

【0013】そして、各スピネル型フェライト粉末に対して30体積パーセント（vol.%）のエポキシ樹脂を混合して混合体とした後、スピネル型フェライト粉末の占積率が約62vol.%となるようにこの混合体を外径10mm、内径2mm、高さ10mm程度の成形体に成形した。そして、このようにして得られた各成形体を温度140℃で2時間保持した後測定用試料とした。

【0014】次に、YHP製インピーダンスアナライザー及び同軸型測定治具を用いてこれら測定用試料におけるμ周波数特性及び損失係数を測定した。その測定結果を図1に示す。

【0015】図1に示すように、これら測定用試料において、最大粒子径が15μmを越える試料では、周波数特性が低下することがわかる。つまり、最大粒子径が15μm以下の測定用試料においては約500MHzでμの減少が始まることがわかる。一方、周波数10MHzにおける損失係数（$\tan\delta_{10MHz}$）は、最大粒子径が7μm以下の試料においては著しく低い値を示し、ほぼ零であることがわかる。なお、これら試料の10MHzにおけるμは約10であった。

【0016】以上の説明から明らかなように、Ni－Zn系スピネルフェライト粉末中の最大粒子径を7μm以下とすれば、単に成形するだけで高周波特性を良好にすることができる。

【0017】実施例2

酸化マンガン（MnO）、酸化亜鉛（ZnO）、及び酸化鉄（$\alpha-Fe_2O_3$）を準備し、共沈法を用いて化学組成比が28MnO・18ZnO・54Fe_2O_3の原料粉末を作成した。この原料粉末の粒子径を観察したところ約30nmの粒子であった。

【0018】次に、この原料粉末を温度700℃乃至1250℃の範囲で焼成して焼成粉末とし、この焼成粉末をボールミルを用いて解砕してそれぞれ粒子径が0.5μm、1.0μm、3.0μm、5.0μm、7.0μm、10.0μm、15.0μm、20.0μm、及び25.0μmの合計９種のスピネル型フェライト粉末を得た。

【0019】そして、これら９種のスピネル型フェライト粉末に対してそれぞれ20vol.％のポリアミド樹脂を混合して混合体とした後、この混合体を加熱成形し、スピネル型フェライト粉末の占積率が約60vol.％となるように外径10mm，内径2mm，高さ10mm程度の成形体（測定用試料）とした。

【0020】これら測定用試料を実施例１と同様の装置を用いてμ周波数特性及び損失係数を測定した。その結果を図２に示す。

【0021】図２に示すように、これら測定用試料において、最大粒子径が15μmを越える試料では、周波数特性が低下することがわかる。つまり、最大粒子径が15μm以下の測定用試料においては約500MHzでμの減少が始まることがわかる。一方、周波数10MHzにおける損失係数（$\tan\delta_{10MHz}$）は、最大粒子径が7μm以下の試料においては著しく低い値を示し、ほぼ零であることがわかる。なお、これら試料の10MHzにおけるμは約１０であった。

【0022】以上の説明から明らかなように、Mn－Zn系スピネルフェライト粉末中の最大粒子径を7μm以下とすれば高周波特性を良好にすることができる。

【0023】実施例３

炭酸マグネシウム（$MgCO_3$）、四三酸化マンガン（Mn_3O_4）、炭酸リチウム（Li_2CO_3）、酸化ニッケル（NiO）、酸化亜鉛（ZnO）、酸化第２銅（CuO）、及び酸化鉄（$\alpha-Fe_2O_3$）を準備し、化学組成比がそれぞれ15MgO・20MnO・15ZnO・50Fe_2O_3、７Li_2O・33ZnO・60Fe_2O_3、20NiO・33ZnO・47Fe_2O_3、25CuO・25ZnO・50Fe_2O_3の原料を作成した。そして、これら原料粉末を実施例１と同様にして焼成して、それぞれ粒子径が約7μm以下となるスピネル型フェライト粉末を生成した。その後、これらスピネル型フェライト粉末に対してそれぞれポリイミド樹脂を約30vol.％混合して混合体とした後、これら混合体を圧縮成形して測定用試料を得た。その測定結果を図３に示す。

【0024】図３から明らかなように、各測定用試料においてμ周波数特性及び損失係数が良好であることがわかる。つまり、種々のスピネル型フェライト粉末中の最大粒子径を7μm以下とすれば高周波特性を良好にすることができる。

【0025】上述の実施例から明らかなように、軟磁性スピネル型フェライト粉末の粒子径（最大粒子径）を7μm以下とすれば、高温で焼結する必要なく、つまり、単に成形体とするだけで高周波特性を良好にすることができる。

【0026】ところで、軟磁性スピネル型フェライト粉末の粒子径が10nm未満であると、フェライト粉末粒子が常磁性的挙動を示すことになって、軟磁性が低下する。このため、軟磁性スピネル型フェライト粉末の粒子径は10nm以上とする必要がある。

【0027】なお、上述の実施例では化学組成比が、15NiO・６CuO・31ZnO・48Fe_2O_3、28MnO・18ZnO・54Fe_2O_3、15MgO・20MnO・15ZnO・50Fe_2O_3、７Li_2O・33ZnO・60Fe_2O_3、20NiO・33ZnO・47Fe_2O_3、25CuO・25ZnO・50Fe_2O_3のスピネル型フェライト粉末について説明したが、本発明はこれら組成系及び組成値のスピネル型フェライトに限定されるものではなく、軟磁性を示すスピネル型フェライト粉末であれば、同様に本発明を適用できる。つまり、最大粒子径を7μm以下で10nm以上とすれば、他の軟磁性スピネル型フェライト粉末においても同様の高周波特性を得ることができる。

【0028】さらに、上述の実施例では、粉末を製造する際、原料粉末又は共沈フェライト粉末を空気中又は窒素雰囲気中で焼成するようにしたが、水熱合成法、噴霧焙焼法等を用いてもよく、いずれにしても原子の拡散及び分散性を向上させるものであればよい。また、焼成雰囲気は酸化性であっても還元性であってもよく、生成物が軟磁性スピネル型フェライトであればよい。

【0029】加えて、上記の実施例では、フェライト粉末に混合する樹脂としてエポキシ樹脂、ポリアミド樹脂、ポリイミド樹脂をあげたが、これら樹脂は粉末成形体の形状保持、粉末の分散、及び粉末間の絶縁のために使用するものである。従って、フェライト粉末に混合する樹脂としては熱硬化性樹脂及び熱可塑性樹脂いずれであってもよく、要求される特性に応じて適宜選択される。例えば、フェライト粉末に混合する樹脂としてフェノール系、シリコン系、ポリエステル系、フッ素系、ポリプロピレン系、塩化ビニル系、フタレート系、ポリウレタン系、ポリエチレン系、天然ゴム、合成ゴムを用いることができる。

【0030】また、上述の実施例では焼成粉末に樹脂を混合して成形する際、プレスによる圧縮成形を用いたが、焼結粉末の集合体が磁心として作用すればよいから、成形の際には、射出成形、押出成形、ロール圧延成形等を用いることができ、いずれにしても、粉末成形体が得られる方法であればどのような方法を用いてもよい。

【0031】

【発明の効果】以上説明したように、本発明では軟磁性スピネル型フェライト粉末においてその粒子径を10nm以上7μmとしているから、単に軟磁性スピネル型フェライト粉末を成形するだけで良好な磁気特性を得ることができる。従って、従来のように焼結工程を必要とせず、その結果、焼結による収縮変形がなく、焼結後の加工が不要となる。さらに、異種材料との複合の際においても、焼結を行っていないから、境界面において拡散がなく特性が劣化することがない。加えて、焼結が不要であるから、省エネルギー化が図れるばかりでなく設備費を安価にすることができる。＊

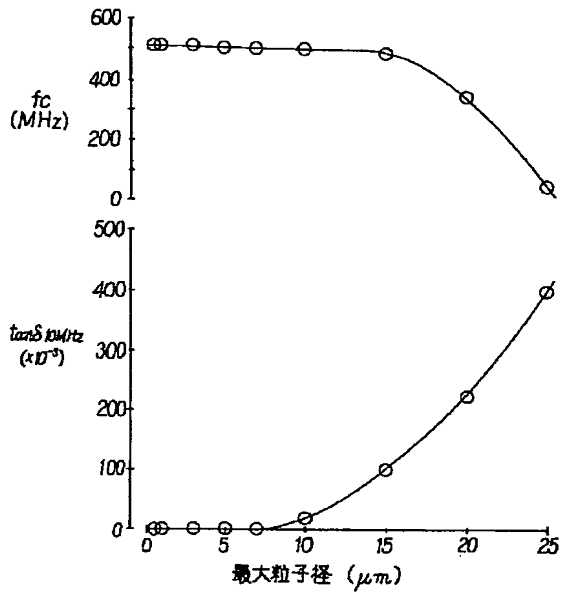
＊【図面の簡単な説明】

【図1】化学組成比が15NiO・6CuO・31ZnO・48Fe₂O₃であるスピネル型フェライト粉末を用いた磁性材料における磁心特性と粉末の最大粒子径との関係を示す図である。

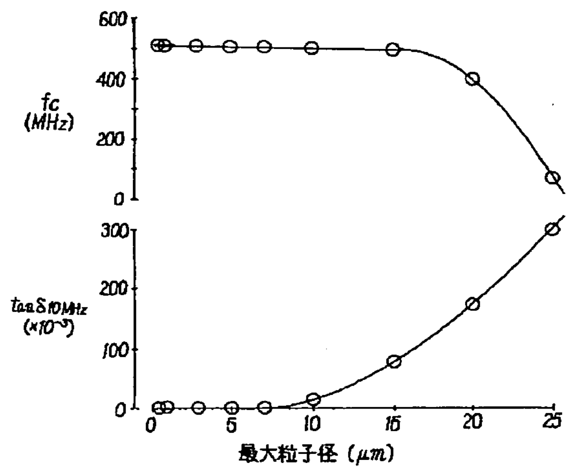
【図2】化学組成比が28MnO・18ZnO・54Fe₂O₃であるスピネルフェライト粉末を用いた磁性材料における磁心特性と粉末の最大粒子径との関係を示す図である。

【図3】種々の化学組成比のスピネル型フェライト粉末を用いた磁性材料の磁心特性を示す図である。

【図1】



【図2】



【図3】

フェライト粉末の組成	fc (MHz)	tanδ 10MHz ($\times 10^{-3}$)
$15MgO \cdot 20MnO \cdot 15ZnO \cdot 50Fe_2O_3$	約500	5
$7Li_2O \cdot 33ZnO \cdot 60Fe_2O_3$	約500	4
$20NiO \cdot 33ZnO \cdot 47Fe_2O_3$	約500	4
$25CuO \cdot 25ZnO \cdot 50Fe_2O_3$	約500	6

Bibliography

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Epitome

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(57) [Abstract]

[Objects of the Invention] The soft magnetic materials which did not need to sinter and were moreover excellent in the RF property are offered.

[Elements of the Invention] A chemical composition ratio is 15NiO, 6 CuO, 31ZnO, and 48Fe 2O3. The becoming mixed powder is calcinated and particle diameter is 7 10nm or more. The spinel ferrite powder below mum is obtained. For example, resin is mixed to this spinel ferrite powder, and it fabricates to a predetermined Plastic solid, and considers as mold goods. For these mold goods, it excels in the RF property and the particle diameter of spinel ferrite powder is 7 10nm or more. If it is below mum, the mold goods which were excellent in the RF property can be obtained without only fabricating, that is, passing through a sintering process.

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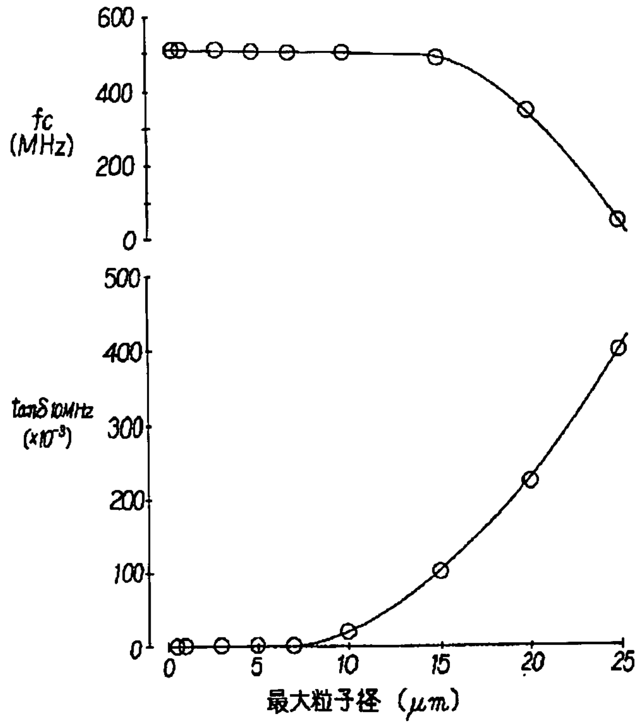

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CLAIMS

[Claim(s)]
[Claim 1] RF soft magnetic materials characterized by particle diameter being soft magnetism spinel ferrite powder 7 micrometers or less in 10nm or more.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application] This invention relates to the soft magnetic materials used in a high frequency band.

[0002]

[Description of the Prior Art] Generally, in this kind of soft magnetic materials, permeability (mu) needs to show a high value also in a high frequency band, and, for this reason, the spinel ferrite ingredient in which a value with a comparatively high electric resistance value is shown is used. Since that property of this spinel ferrite ingredient is weak hard moreover, it is difficult to process it. For this reason, after fabricating ferrite powder or raw material powder in a desired configuration, powder-metallurgy processing which sinters this Plastic solid and is used as a sintered compact is used.

[0003]

[Problem(s) to be Solved by the Invention] However, in case the above-mentioned sintered compact is obtained, in order to sinter a Plastic solid at an elevated temperature (1000 degrees C thru/or 1400 degrees C), and for deformation to arise in a sintered compact by the so-called sintering contraction in sintering in such an elevated temperature, consequently to consider as a desired configuration, it is necessary to process it into a sintered compact.

[0004] There is a trouble it is not only accompanied by consumption of great energy, but that a sintering facility will be expensive in sintering in the above elevated temperatures. Furthermore, generally it is difficult to process it into a sintered compact, and for this reason, there is only that no processing costs increase and it will only lead to loss of an ingredient.

[0005] Furthermore, although it is desirable to carry out sintering

processing of the spinel ferrite ingredient at a small configuration when the field of effectiveness is taken into consideration in case it is used in a high frequency band, processing to a small configuration has the trouble that it is very difficult in respect of process tolerance. Although such a ferrite ingredient (inductor component) and a dielectric material (capacitative element) may really be sintered on the other hand and a L-C component may be constituted, with such a L-C component, it will set to the plane of composition of ingredients, and the field where a property deteriorates by diffusion of the atom at the time of sintering will be generated.

[0006] Anyway, the above various troubles will occur by including a sintering process.

[0007] The purpose of this invention is to offer the soft magnetic materials which did not need to sinter and were moreover excellent in the RF property.

[0008]

[Means for Solving the Problem] According to this invention, the RF soft magnetic materials to which particle diameter comes out of soft magnetism spinel ferrite powder 7 micrometers or less by 10nm or more, and is characterized by a certain thing are obtained.

[0009]

[Function] At this invention, particle diameter is 7 10nm or more as RF soft magnetic materials. The soft magnetism spinel ferrite powder below mum is used. Such soft magnetism spinel ferrite powder is only fabricated in a desired configuration, it only considers as a Plastic solid, and outstanding magnetic properties can be acquired. And the particle diameter of a soft magnetism spinel ferrite is 7. If mum is exceeded, loss (for example, loss factor delta10MHz in 10MHz) will increase as a magnetic material. On the other hand, a ferrite powder particle presents paramagnetism-behavior as the particle diameter of a soft magnetism spinel ferrite is less than 10nm, and soft magnetism falls.

[0010]

[Example] An example explains this invention below.

[0011] For example 1 grain size, grain size is 0.5. The nickel oxide (NiO) which is below mum, the 2nd copper (CuO) of oxidation, a zinc oxide (ZnO), and ferrous oxide (alpha-Fe 2O3) are prepared, wet blending of these powder is carried out using a ball mill, and a chemical composition ratio is 15NiO, 6 CuO, 31ZnO, and 48Fe 2O3. The becoming raw material mixing powder was obtained.

[0012] Next, this raw material mixing powder was calcinated in

temperature 750 ** thru/or 1200 degrees C in rapid heating and quenching in atmospheric air, and baking powder was obtained. And this baking powder is cracked using a ball mill, and it is particle diameter 0.5, respectively. mum and 1.0 mum and 3.0 mum and 5.0 mum and 7.0 A total of nine kinds of spinel ferrite powder (mum, 10.0 micrometers, 15.0 micrometers, 20.0 micrometers, and 25.0 micrometers or less) was obtained.
[0013] And after mixing the epoxy resin of 30 percents by volume (vol.%) to each spinel ferrite powder and considering as a mixture, this mixture was fabricated to the outer diameter of 10mm, bore 2 mm, and a Plastic solid with a height of about 10mm so that the space factor of spinel ferrite powder might become about 62 vol(s).%. And after holding each Plastic solid acquired by doing in this way by temperature 140 ** for 2 hours, it considered as the test sample.
[0014] Next, mu frequency characteristics and the loss factor in these test samples were measured using the impedance analyzer made from YHP, and the coaxial-type fixture. The measurement result is shown in drawing 1 .
[0015] As shown in drawing 1 , in these test samples, it turns out that frequency characteristics fall by the sample by which the maximum particle diameter exceeds 15 micrometers. That is, it turns out that reduction in mu starts [the maximum particle diameter] in about 500 MHz in a test sample 15 micrometers or less. For a loss factor [in / on the other hand / the frequency of 10MHz] (tandelta10MHz), the maximum particle diameter is 7. A remarkable low value is shown in the sample below mum, and it turns out that it is about 0. In addition, mu in 10MHz of these samples was about 10.
[0016] It is the maximum particle diameter in nickel-Zn system spinel ferrite powder so that clearly from the above explanation 7 A RF property can be made good below mum, then only by fabricating.
[0017] Example diacid-ized manganese (MnO), a zinc oxide (ZnO), and an iron oxide (alpha-Fe 2O3) are prepared, a coprecipitation method is used, and a chemical composition ratio is 28MnO, 18ZnO, and 54Fe 2O3. Raw material powder was created. When the particle diameter of this raw material powder was observed, it was about 30nm particle.
[0018] Next, this raw material powder is calcinated in temperature 700 ** thru/or 1250 degrees C, it considers as baking powder, this baking powder is cracked using a ball mill, and particle diameter is 0.5, respectively. mum and 1.0 mum and 3.0 mum and 5.0 mum and 7.0 A total of nine sorts of spinel ferrite powder which is mum, 10.0 micrometers, 15.0 micrometers, 20.0 micrometers, and 25.0 micrometers was obtained.

[0019] And after mixing the polyamide resin of 20vol(s).% to these nine sorts of spinel ferrite powder, respectively and considering as a mixture, hot forming of this mixture was carried out, and it considered as the outer diameter of 10mm, bore 2 mm, and a Plastic solid (test sample) with a height of about 10mm so that the space factor of spinel ferrite powder might become about 60 vol(s).%.
[0020] mu frequency characteristics and a loss factor were measured for these test samples using the same equipment as an example 1. The result is shown in drawing 2 .
[0021] As shown in drawing 2 , in these test samples, it turns out that frequency characteristics fall by the sample by which the maximum particle diameter exceeds 15 micrometers. That is, it turns out that reduction in mu starts [the maximum particle diameter] in about 500 MHz in a test sample 15 micrometers or less. For a loss factor [in / on the other hand / the frequency of 10MHz] (tandelta10MHz), the maximum particle diameter is 7. A remarkable low value is shown in the sample below mum, and it turns out that it is about 0. In addition, mu in 10MHz of these samples was about 10.
[0022] It is the maximum particle diameter in Mn-Zn system spinel ferrite powder so that clearly from the above explanation 7 Below mum, then a RF property can be made good.
[0023] Example 3 magnesium carbonate (MgCO3), trimanganese tetroxide (Mn 304), A lithium carbonate (Li2 CO3), nickel oxide (NiO), a zinc oxide (ZnO), The 2nd copper (CuO) of oxidation and an iron oxide (alpha-Fe 203) are prepared. a chemical composition ratio -- respectively -- 15MgO, 20MnO, 15ZnO and 50Fe 203, 7 Li2 O, 33ZnO and 60Fe 203, 20NiO, 33ZnO and 47Fe 203, and 25CuO, 25ZnO and 50Fe 203 The raw material was created. And these raw material powder is calcinated like an example 1, and particle diameter is about 7, respectively. The spinel ferrite powder which becomes below mum was generated. Then, these mixtures were pressed and the test sample was obtained, after doing about 30 vol(s).% mixing of polyimide resin to these spinel ferrite powder, respectively and considering as a mixture. The measurement result is shown in drawing 3 .
[0024] In each test sample, it turns out that mu frequency characteristics and a loss factor are good so that clearly from drawing 3 . That is, it is the maximum particle diameter in various spinel ferrite powder 7 Below mum, then a RF property can be made good.
[0025] It is the particle diameter (the maximum particle diameter) of soft magnetism spinel ferrite powder so that clearly from an above-mentioned example 7 A RF property can be made good only by not sintering at below mum, then an elevated temperature, that is, considering as a

Plastic solid.
[0026] By the way, a ferrite powder particle will show paramagnetism-behavior that the particle diameter of soft magnetism spinel ferrite powder is less than 10nm, and soft magnetism falls. For this reason, it is necessary to set the particle diameter of soft magnetism spinel ferrite powder to 10nm or more.
[0027] A chemical composition ratio in the above-mentioned example In addition, 15NiO, 6 CuO, 31ZnO, and 48Fe 203, 28MnO, 18ZnO and 54Fe 203, and 15MgO, 20MnO, 15ZnO and 50Fe 203, 7 Li2 0, 33ZnO and 60Fe 203, 20NiO, 33ZnO and 47Fe 203, and 25CuO, 25ZnO and 50Fe 203 Although spinel ferrite powder was explained This invention is not limited to the spinel ferrite of these presentation system and a presentation value, and if it is spinel ferrite powder in which soft magnetism is shown, it can apply this invention similarly. That is, it is the maximum particle diameter 7 Also in 10nm or more, then other soft magnetism spinel ferrite powder, the same RF property can be acquired below by mum.
[0028] Furthermore, what is necessary is to use a hydrothermal crystallization method, spray roasting, etc. and just to raise atomic diffusion and dispersibility anyway, although raw material powder or coprecipitation ferrite powder was calcinated in air or nitrogen-gas-atmosphere mind in the above-mentioned example when manufacturing powder. Moreover, a firing environments may be an oxidizing quality, or may be reducibility, and a product should just be a soft magnetism spinel ferrite.
[0029] In addition, although an epoxy resin, polyamide resin, and polyimide resin were raised with the above-mentioned example as resin mixed to ferrite powder, these resin is used for configuration maintenance of a powder-molding object, powdered distribution, and the insulation between powder. therefore -- as the resin mixed to ferrite powder -- thermosetting resin and thermoplastics -- you may be any and it is suitably chosen according to the property demanded. For example, a phenol system, a silicon system, a HORIESUTERU system, a fluorine system, the Horipro pyrene system, a vinyl chloride system, a phthalate system, a polyurethane system, a HORIECHIREN system, natural rubber, and synthetic rubber can be used as resin mixed to ferrite powder.
[0030] Moreover, when mixing and fabricating resin to baking powder in the above-mentioned example, compression molding by the press was used in it, but since the aggregate of sintering powder should just act as a core, in the case of shaping, injection molding, extrusion molding, roll rolling shaping, etc. can be used, and as long as it is the approach by which a powder-molding object is acquired, what kind of approach may be

used anyway.
[0031]
[Effect of the Invention] As explained above, in this invention, it sets to soft magnetism spinel ferrite powder, and it is the particle diameter 10nm or more 7 Since it is referred to as mum, good magnetic properties can be acquired only by fabricating soft magnetism spinel ferrite powder. Therefore, a sintering process is not needed like before, consequently there is no contraction deformation by sintering, and processing after sintering becomes unnecessary. Furthermore, since it is not sintering in the case of compound with a dissimilar material, there is no diffusion in an interface and a property does not deteriorate. In addition, since sintering is unnecessary, it not only can attain energy saving, but it can make an installation cost cheap.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] a chemical composition ratio -- 15NiO, 6 CuO, 31ZnO, and 48Fe 203 it is -- it is drawing showing the relation of the core property and the powdered maximum particle diameter in the magnetic material using spinel ferrite powder.
[Drawing 2] a chemical composition ratio -- 28MnO, 18ZnO, and 54Fe 203 it is -- it is drawing showing the relation of the core property and the powdered maximum particle diameter in the magnetic material using spinel ferrite powder.
[Drawing 3] It is drawing showing the core property of the magnetic material using the spinel ferrite powder of various chemical composition ratios.

[Translation done.]

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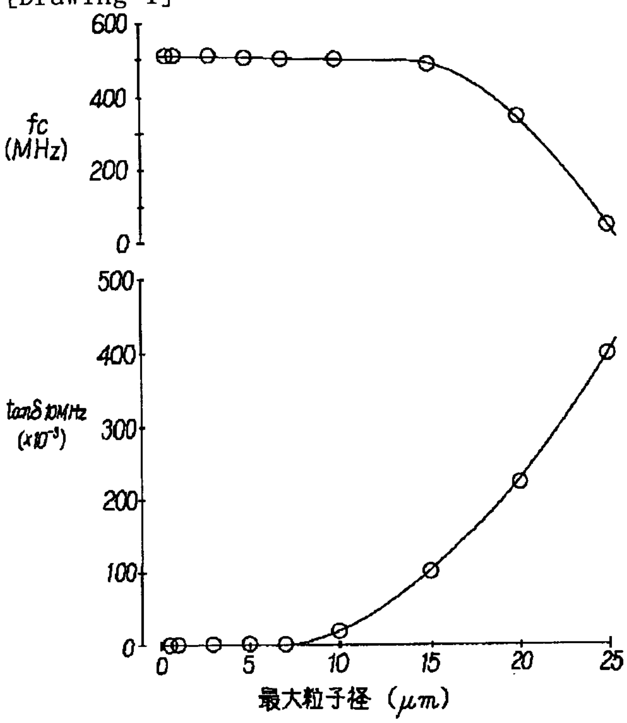
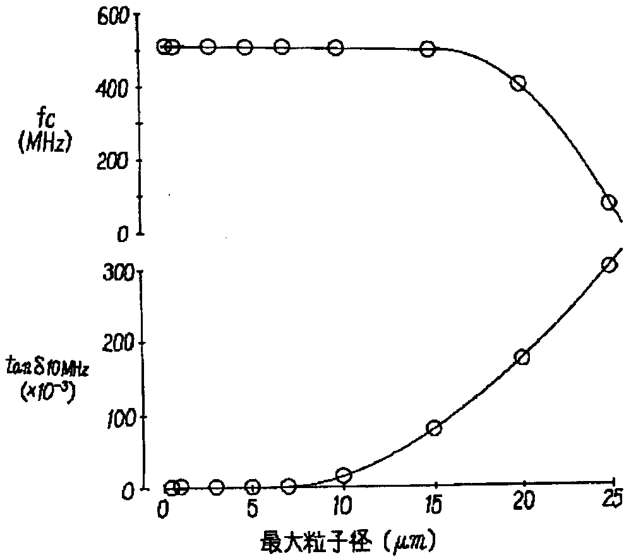
DRAWINGS

[Drawing 1]



[Drawing 2]



[Drawing 3]

フェライト粉末の組成	fc (MHz)	tanδ 10MHz ($\times 10^{-3}$)
$15MgO \cdot 20MnO \cdot 15ZnO \cdot 50Fe_2O_3$	約500	5
$7Li_2O \cdot 33ZnO \cdot 60Fe_2O_3$	約500	4
$20NiO \cdot 33ZnO \cdot 47Fe_2O_3$	約500	4
$25CuO \cdot 25ZnO \cdot 50Fe_2O_3$	約500	6

[Translation done.]